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2800 Powder Mill Road
Adelphi, Md., 28785-1197

Army exploring microturbines as soldier power source

Gas turbine engines power the Army's Apache helicopters and M1A2 Abrams tanks. But someday, a gas turbine engine might replace the batteries to power your portable radio or CD player: a microturbine. In the future, the individual soldier's equipment, as well as commercially available items, could also be powered by a gas turbine engine: a microturbine.

The Massachusetts Institute of Technology, working with ARL support through it's Army Research Office, is working to develop such an engine. Microturbines represent an innovative approach to providing a power source that potentially has some five to 10 times the energy density of batteries. The concept relies on two key ideas.

First, the energy obtained from a liquid hydrocarbon fuel burned in air is roughly 100 times the energy of a similar weight of batteries.

Second, the same microfabrication technology developed to make computer chips can be used to fabricate microturbines, conceivably at similar affordable costs.
Although there are many technical hurdles to building such devices the first 5 years of the microturbine program conducted at MIT have demonstrated numerous successes, such as spinning turbines at speeds up to 1.4 million RPM.

If microturbines are able to reach projected efficiencies of 10 percent, then a two-d pound container of fuel could provide more electrical energy than seven batteries, which together weigh more than 15 pounds. The Army is interested in microturbines to power the individual soldier's equipment.

Contact Dave Davison, 301 394-2302
or e-mail ddavison@arl.army.mil

Breathable materials eyed for soldier protective gear

Soldier protection requires special clothing that acts as a physical barrier to toxic vapors, liquids, and aerosols, including chemical and biological weapons.

This protection must not only be a barrier to toxins but must also be permeable to water to reduce incapacitating heat stress, light weight, flexible, and cost effective. Permselective membranes are the first technology that satisfies the technical requirements for CBW protective materials that are breathable, cost effective alternatives to presently used materials ARL is working on the concept that the simultaneous fulfillment of CBW protection coupled with comfort is possible through the manipulation of molecular architecture in polymers.

After preparing a polymer with blocks of flexible polymer, polyisobutylene, and a glassy polymer, polystyrene, the polystyrene blocks self assemble into channels. Chemical modification of the channels is carried out changing their composition so that water transport through them is facilitated. Preliminary permeability measurements have indicated that the new material is an effective barrier to toxic materials while being permeable to water, enhancing the wearer’s comfort.

Contact Virginia Bailey, 410 278-5964
or e-mail vbailey @arl.army.mil

ARL, NASA working together to develop ultra-reliability

An ongoing ARL/NASA collaborative program is addressing deficiencies in composites reliability and durability to enhance vehicle structural integrity. The need for the Army to be more deployable, agile, survivable and mobile with a smaller logistic footprint, will require dramatic increases in vehicle reliability and durability.

ARL is expanding its initiative in those areas to provide materials and structures technologies that will enable design and manufacture of lighter, more durable, and highly reliable combat vehicles in less time. A major effort is currently underway with the U.S. helicopter industry to develop improved failure criteria for composites. The results will provide advanced rotor hub designs that extend reliability and reduce maintenance costs.

The cost of maintenance is a large share of the Army budget. A focused S&T program in ultra-reliability will reduce those costs. The payoff will be significant reductions in logistics support and the corresponding ability to perform specified wartime missions without system failures. This added capability will require a ten-fold or more increase in vehicle reliability.

Technical barriers include inadequate materials/structures analytical models to accurately predict failure, incomplete experimental data to characterize material behavior and structural loads, and inaccurate and hard to use inspection and tracking methods.

The technical approach to overcome these barriers requires accelerated development and substantiation of material characterization and failure models as well as innovative inspection techniques to assess damage and structural integrity in the field.

Providing ultra-reliability means that systems in future Army vehicles such as the Future Combat System and Future Transport Rotorcraft will rarely fail before reaching their expected retirement lives. The Army vision of lighter, more lethal, and highly reliable weapons platforms can be met with a commensurate two-thirds reduction in maintenance requirements by 2020.

Contact Dave Davison, 301 394-2302
or e-mail ddavison@arl.army.mil

Army Research Laboratory
Attn: AMSRL-CS-PA
2800 Powder Mill Road
Adelphi, MD 20783-1197